PRELIMINARY

NLT Technologies, Ltd.

TFT COLOR LCD MODULE

NLB121SV01L-01

31cm (12.1 Type)
SVGA
LVDS interface (1port)

PRELIMINARY DATA SHEET

DOD-PP-1446 (8th edition)

This PRELIMINARY DATA SHEET is updated document from DOD-PP-1444(7).

All information is subject to change without notice. Please confirm the sales representative before starting to design your system.

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INTRODUCTION

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Each quality grade is designed for applications described below. Any customer who intends to use a product for application other than that of Standard is required to contact an NLT sales representative in advance.

The **Standard:** Applications as any failure, malfunction or error of the products are free from any damage to death, human bodily injury or other property (Products Safety Issue) and not related the safety of the public (Social Issues), like general electric devices.
Examples: Office equipment, audio and visual equipment, communication equipment, test and measurement equipment, personal electronic equipment, home electronic appliances, car navigation system (with no vehicle control functions), seat entertainment monitor for vehicles and airplanes, fish finder (except marine radar integrated type), PDA, etc.

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Examples: Vehicle/train/ship control system, traffic signals system, traffic information control system, air traffic control system, surgery/operation equipment monitor, disaster/crime prevention system, etc.

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Examples: Aerospace system (except seat entertainment monitor), nuclear control system, life support system, etc.

The quality grade of this product is the **"Standard"** unless otherwise specified in this document.

PRELIMINARY

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1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NLB121SV01L-01 is composed of the amorphous silicon thin film transistor liquid crystal display (a-Si TFT LCD) panel structure with driver LSIs for driving the TFT (Thin Film Transistor) array and a backlight.

The a-Si TFT LCD panel structure is injected liquid crystal material into a narrow gap between the TFT array glass substrate and a color-filter glass substrate.

Color (Red, Green, Blue) data signals from a host system (e.g. signal generator, etc.) are modulated into best form for active matrix system by a signal processing board, and sent to the driver LSIs which drive the individual TFT arrays.

The TFT array as an electro-optical switch regulates the amount of transmitted light from the backlight assembly, when it is controlled by data signals. Color images are created by regulating the amount of transmitted light through the TFT array of red, green and blue dots.

1.2 APPLICATION

- For industrial use

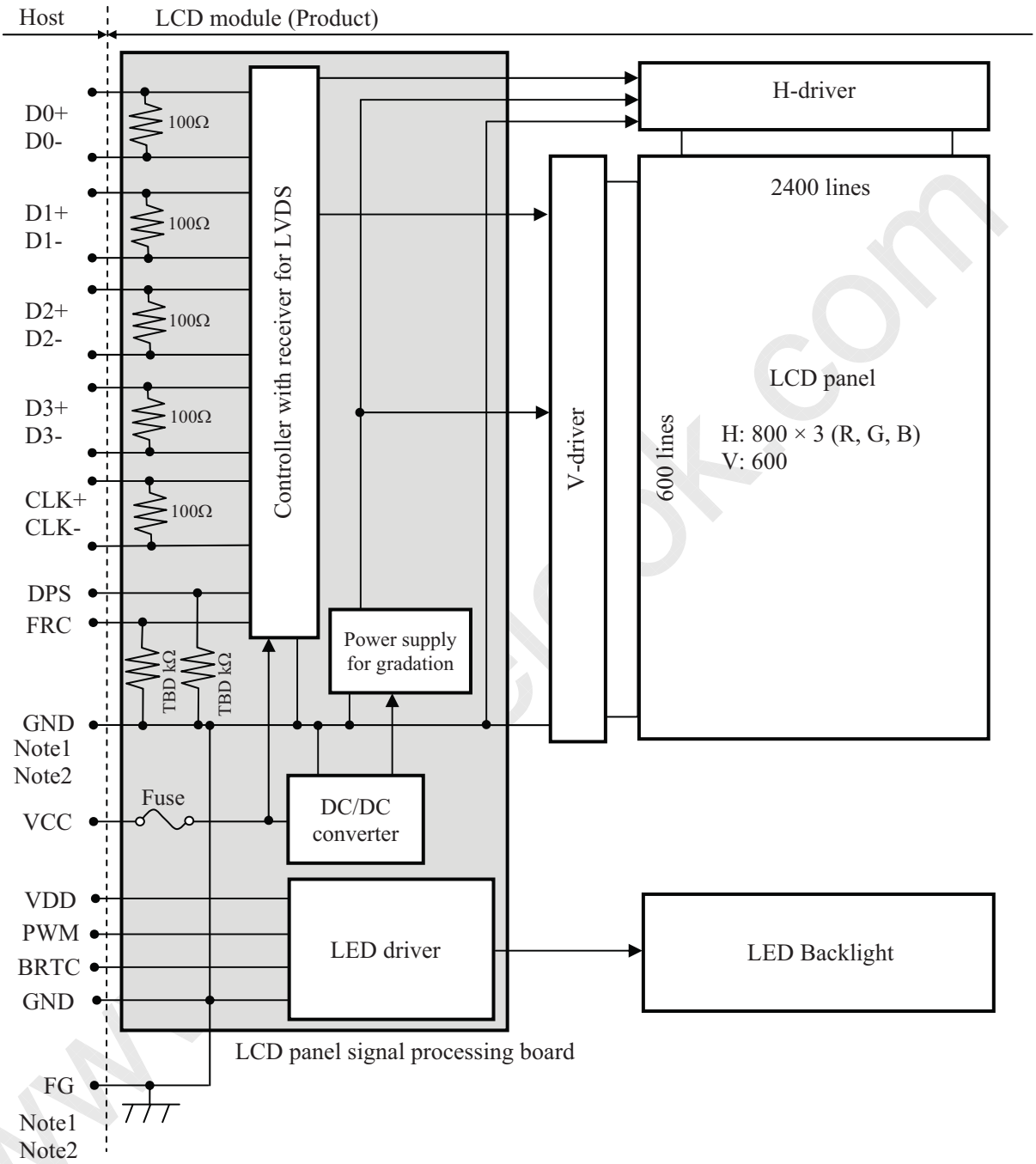
1.3 FEATURES

- High luminance
- High contrast
- Wide viewing angle
- Wide temperature range
- LVDS interface
- Reversible-scan direction
- Selectable 8bit or 6bit digital signals for data of RGB
- Long life LED backlight type
- Replaceable lamp holder for backlight

2. GENERAL SPECIFICATIONS

Display area	246.0 (H) × 184.5 (V) mm
Diagonal size of display	31cm (12.1 inches)
Drive system	a-Si TFT active matrix
Display color	16,194,277 colors (At 8-bit input, FRC terminal= VCC) 262,144 colors (At 6-bit input, FRC terminal= GND or Open)
Pixel	800 (H) × 600 (V) pixels
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe
Dot pitch	0.1025 (H) × 0.3075 (V) mm
Pixel pitch	0.3075 (H) × 0.3075 (V) mm
Module size	279.0 mm (H) (typ.) × 209.0 mm (V) (typ.) × 9.0 (D) mm (typ.)
Weight	540 g (typ.)
Contrast ratio	700:1 (typ.)
Viewing angle	*At the contrast ratio ≥10:1* • Horizontal: Right side 80° (typ.), Left side 80° (typ.) • Vertical: Up side 65° (typ.), Down side 75° (typ.)
Polarizer surface	Antiglare
Polarizer pencil-hardness	3H (min.) [by JIS K5600]
Color gamut	*At LCD panel center* 55% (typ.) [against NTSC color space]
Response time	*Ton+Toff (10%←→90%)* 35ms (typ.)
Luminance	*At the maximum luminance control* 450cd/m^2 (typ.)
Signal system	LVDS 1port [8bit/6bit digital signals for data of RGB colors, Dot clock (CLK), Data enable (DE)]
Power supply voltage	LCD panel: 3.3V LED backlight: 12V
Backlight	LED backlight type (Replaceable part • Lamp holder set: Type No. TBD)
Power consumption	*At the maximum luminance control, Gray pattern* ≤ 10 W (typ.)

3. BLOCK DIAGRAM



Note1: Relations between GND (Signal ground and LED driver ground) and FG (Frame ground) in the LCD module are as follows.

GND- FG	Connected

Note2: GND and FG must be connected to customer equipment's ground, and it is recommended that these grounds be connected together in customer equipment.

4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification		Unit
Module size	279.0 ± 0.5 (W) × 209.0 ± 0.5 (H) × 9.0 ± 0.5 (D)	Note1	mm
Display area	246.0 (H) × 184.5 (V)	Note1	mm
Weight	540 (typ.), TBD (max.)		g

Note1: See "**8. OUTLINE DRAWINGS**".

4.2 ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Rating	Unit	Remarks
Power supply voltage	LCD panel	VCC	-0.3 to +3.6	V	Ta= 25°C
	LED driver	VDD	-0.3V to +26.5V		
Input voltage for signals	Display signals Note1	VD	-0.3 to +1.98	V	
	Function signals Note2	VF	-0.3 to VCC		
	Function signal for LED driver	PWM	-0.3V to +26.5V	V	
		BRTC	-0.3V to +26.5V	V	
Storage temperature		Tst	-30 to +80	°C	-
Operating temperature	Front surface	TopF	-20 to +70	°C	Note3
	Rear surface	TopR	-20 to +70	°C	Note4
Relative humidity Note5		RH	≤ 90	%	Ta ≤ 40°C
Absolute humidity Note5		AH	≤ 70 Note6	g/m^3	Ta > 70°C

Note1: D0+/-, D1+/-, D2+/-, D3+/- and CLK+/-
Note2: FRC and DPS
Note3: Measured at LCD panel surface (including self-heat)
Note4: Measured at LCD module's rear shield surface (including self-heat)
Note5: No condensation

4.3 ELECTRICAL CHARACTERISTICS

4.3.1 LCD panel signal processing board

(Ta= 25°C)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
Power supply voltage		VCC	3.0	3.3	3.6	V	-
Power supply current		ICC	-	280 Note1	≤ 606 Note2	mA	at VCC= 3.3V
Permissible ripple voltage		VRPC	-	-	300	mVp-p	for VCC
Differential input threshold voltage	High	VTH	-	-	+100	mV	at VCM= 1.25V Note3
	Low	VTL	-100	-	-	mV	
Terminating resistance		RT	-	100	-	Ω	-
Input voltage for DPS and FRC signals	High	VFH	0.7*VCC	-	VCC	V	-
	Low	VFL	0	-	0.3*VCC	V	

Note1: Checkered flag pattern [by EIAJ ED-2522]
Note2: Pattern for maximum current
Note3: Common mode voltage for LVDS receiver

4.3.2 Backlight lamp

(Ta= 25°C)

Parameter		Symbol	min.	typ.	max.	Unit	Remarks
Power supply voltage		VDD	10.8	12.0	12.6	V	Note1
Power supply current		IDD	-	480	≤ 666 Note2	mA	At the maximum luminance control. Note3
Permissible ripple voltage		VRPD	-	-	200	mVp-p	for VDD
Input voltage for PWM signals	High	VDFH1	1.2	-	-	V	-
	Low	VDFL1	-	-	0.4	V	
Input voltage for BRTC signals	High	VDFH2	1.5	-	-	V	-
	Low	VDFL2	0	-	0.8	V	
PWM frequency		f_{PWM}	200	-	10k	Hz	Note4, Note5
PWM pulse width		tPWH	1	-	-	μs	-

Note1: When designing of the power supply, take the measures for the prevention of surge voltage.
Note2: This value excludes peak current such as overshoot current.
Note3: The power supply lines (VDD and GND) may have ripple voltage during luminance control of LED. There is the possibility that the ripple voltage produces acoustic noise and signal wave noise in audio circuit and so on. Put a capacitor between the power supply lines (VDD and GND) to reduce the noise if necessary.
Note4: A recommended f_{PWM} value is as follows.

$$f_{PWM} = \frac{2n-1}{4} \times fv$$

$$(n = \text{integer}, fv = \text{frame frequency of LCD module})$$

Note5: Depending on the frequency used, so noise may appear on the screen, please conduct a thorough evaluation.

4.3.3 Power supply voltage ripple

This product works, even if the ripple voltage levels are over the permissible values as the following table, but there might be noise on the display image.

Power supply voltage		Ripple voltage Note1 (Measure at input terminal of power supply)	Unit
VCC	3.3V	≤ 300	mVp-p
VDD	12.0V	≤ 200	mVp-p

Note1: The permissible ripple voltage includes spike noise.

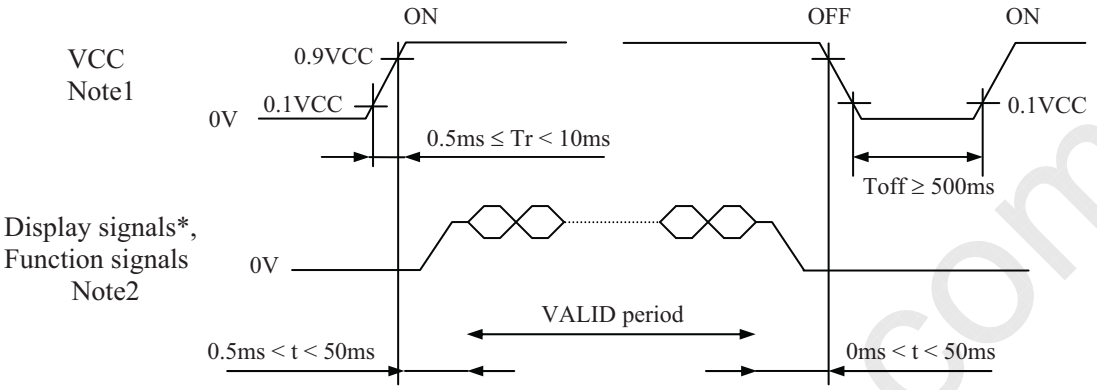
4.3.4 Fuse

Parameter	Fuse		Rating	Fusing current	Remarks
	Type	Supplier			
VCC	FCC16152AB	KAMAYA ELECTRIC Co., Ltd.	1.5A 36V	3.0A	Note1
VDD	FCC16152AB	KAMAYA ELECTRIC Co., Ltd.	1.5A 36V	3.0A	

Note1: The power supply's rated current must be more than the fusing current. If it is less than the fusing current, the fuse may not blow in a short time, and then nasty smell, smoke and so on may occur.

4.4 POWER SUPPLY VOLTAGE SEQUENCE

4.4.1 LCD panel

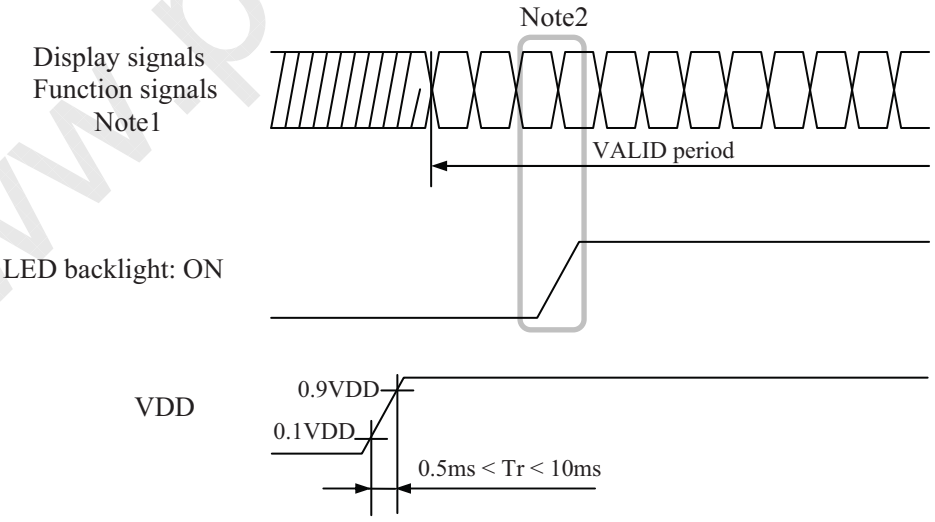


* These signals should be measured at the terminal of 100Ω resistance.

Note1: If there is a voltage variation (voltage drop) at the rising edge of VCC below 0.9VCC, there is a possibility that a product does not work due to a protection circuit.

Note2: Display signals (D0+/-, D1+/-, D2+/-, D3+/- and CLK+/-) and function signals (DPS and FRC) must be set to Low or High-impedance, except the VALID period (See above sequence diagram), in order to avoid the circuitry damage.
If some of display and function signals of this product are cut while this product is working, even if the signal input to it once again, it might not work normally. If a customer stops the display and function signals, VCC also must be shut down.

4.4.2 LED driver board



Note1: These are the display and function signals for LCD panel signal processing board.

Note2: The backlight should be turned on within the valid period of display and function signals, in order to avoid unstable data display.

4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS

4.5.1 LCD panel signal processing board

CN1 socket (LCD module side): MSB240420HE (Produced by STM)
Adaptable plug: DF14-20S-1.25C (Hirose Electric Co., Ltd. (HRS))

Pin No.	Symbol	Signal	Remarks
1	VCC	Power supply	Note1
2	VCC		
3	GND	Ground	Note1
4	FRC	Select 6 or 8 bit LVDS input	VCC: 8Bit, GND / N. C: 6Bit Note3, Note4
5	D0-	Pixel data	Note2
6	D0+		
7	GND	Ground	Note1
8	D1-	Pixel data	Note2
9	D1+		
10	GND	Ground	Note1
11	D2-	Pixel data	Note2
12	D2+		
13	GND	Ground	Note1
14	CLK-	Pixel clock	Note2
15	CLK+		
16	GND	Ground	Note1
17	D3-/NC	Pixel data	Used for 8Bits LVDS input; N.C for 6Bits Note2
18	D3+/NC		
19	DPS	Display reverse function	VCC: Reverse display GND/N. C: Normal display Note5
20	N. C./GND	Test function pin	Do not set this pin to high

Note1: All GND, VCC and VDD terminals should be used without any non-connected lines.
Note2: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.
Note3: See "**4.6 DISPLAY COLORS AND INPUT DATA SIGNALS**".
Note4: See "**4.5.4 Connection between receiver and transmitter for LVDS**".
Note5: See "**4.8 SCANNING DIRECTIONS**".

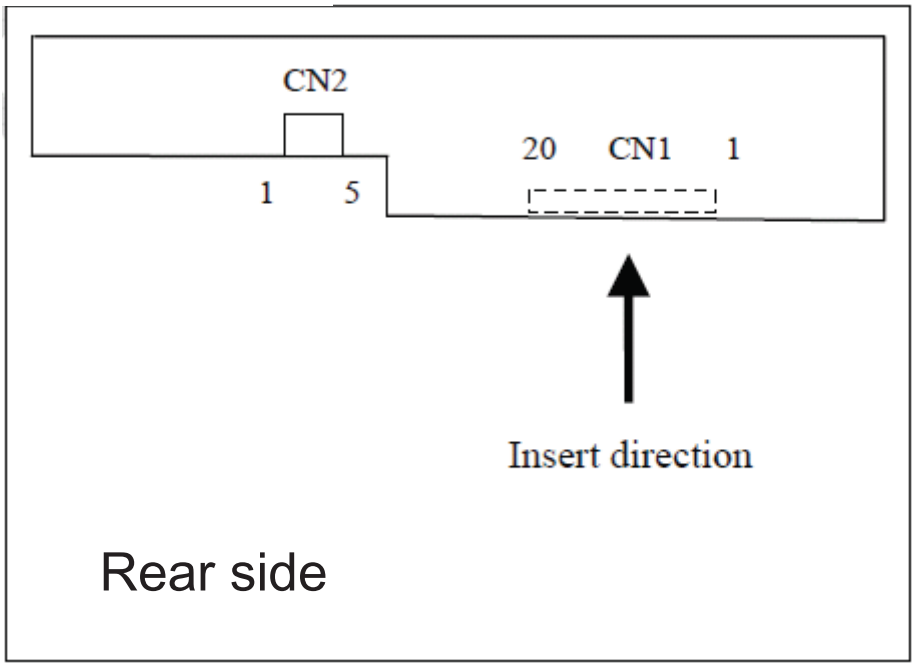
4.5.2 Backlight lamp

CN2 socket (LCD module side): MSB24038P5 (Produced by STM)
Adaptable plug: P24038P5 (Produced by STM)

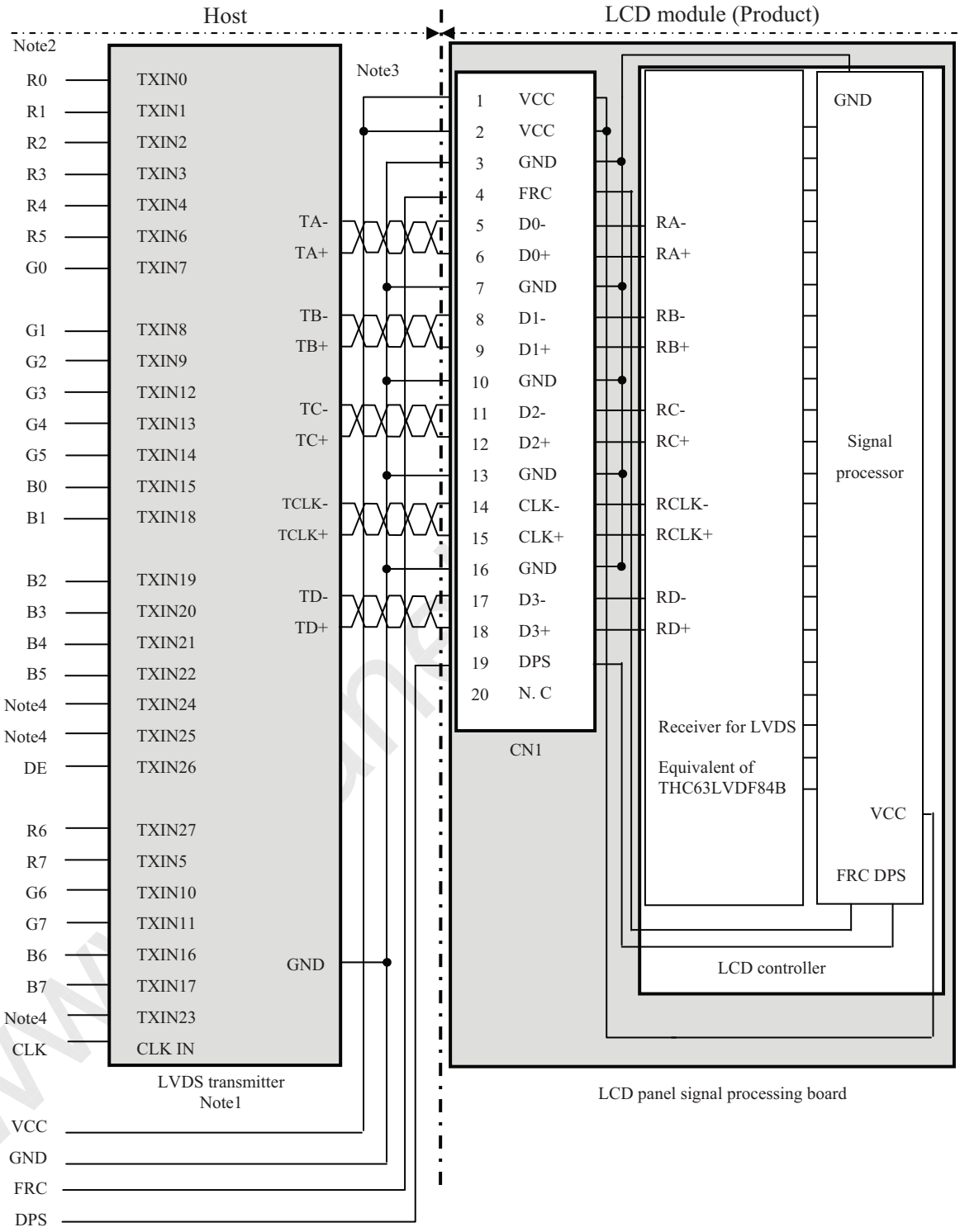
Pin No.	Symbol	Signal	Remarks
1	VDD	Power supply	Note1
2	GND	Ground	Note1
3	BRTC	Back light ON/OFF control	High- On / Low- Off
4	PWM	Luminance control	PWM Dimming
5	N. C.	Non connection	Keep this pin Open.

Note1: All GND, VCC and VDD terminals should be used without any non-connected lines.

4.5.3 Positions of plug and socket

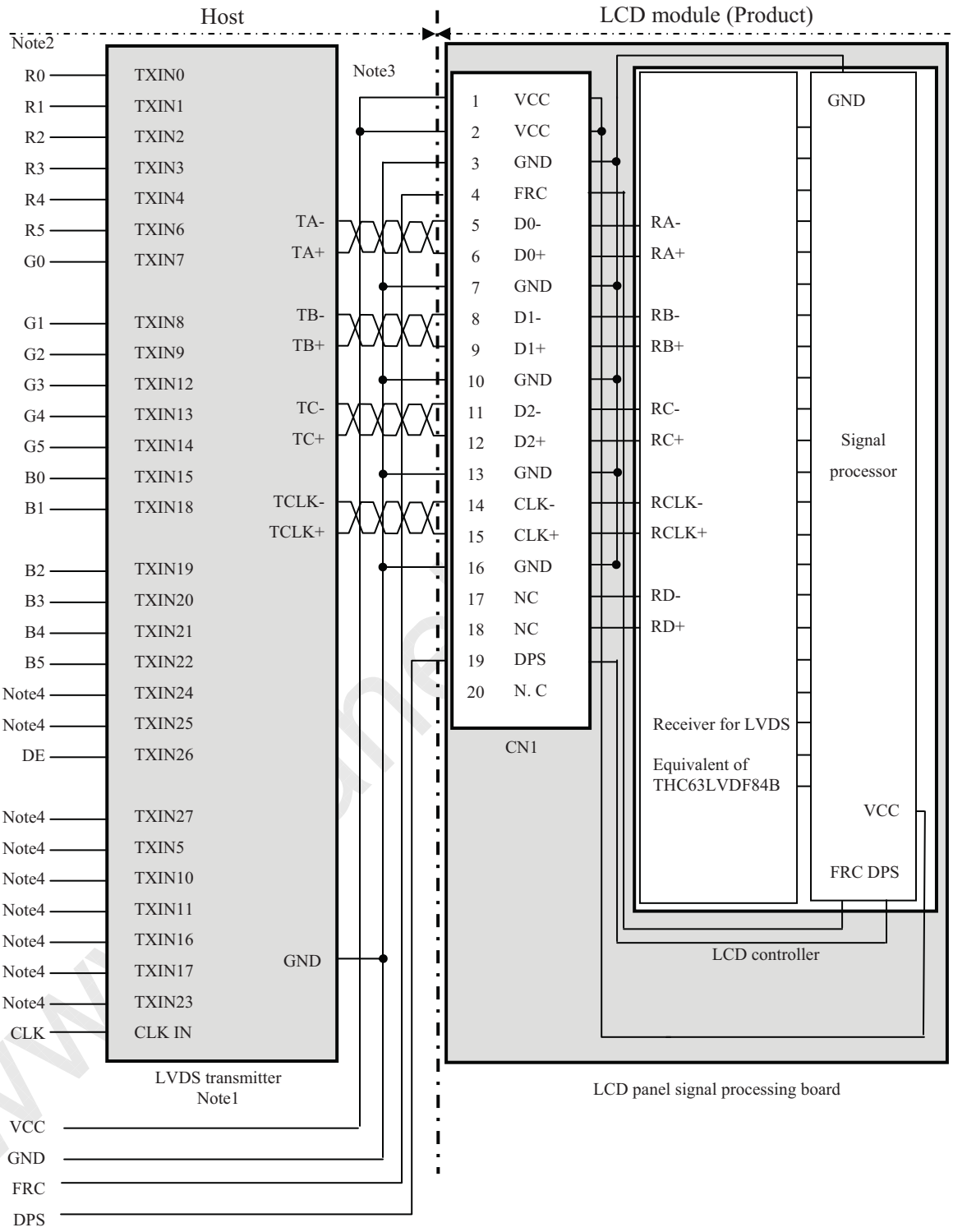


4.5.4 Connection between receiver and transmitter for LVDS
(1) Input data signal: 8bit



Note1: Recommended transmitter: DS90C383 (National Semiconductor) or equivalent
Note2: LSB (Least Significant Bit) - R0, G0, B0 MSB (Most Significant Bit) - R7, G7, B7
Note3: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.
Note4: Input signals to TXIN23, TXIN24 and TXIN25 are not used inside the product, but do not keep TXIN23, TXIN24 and TXIN25 open to avoid noise problem.

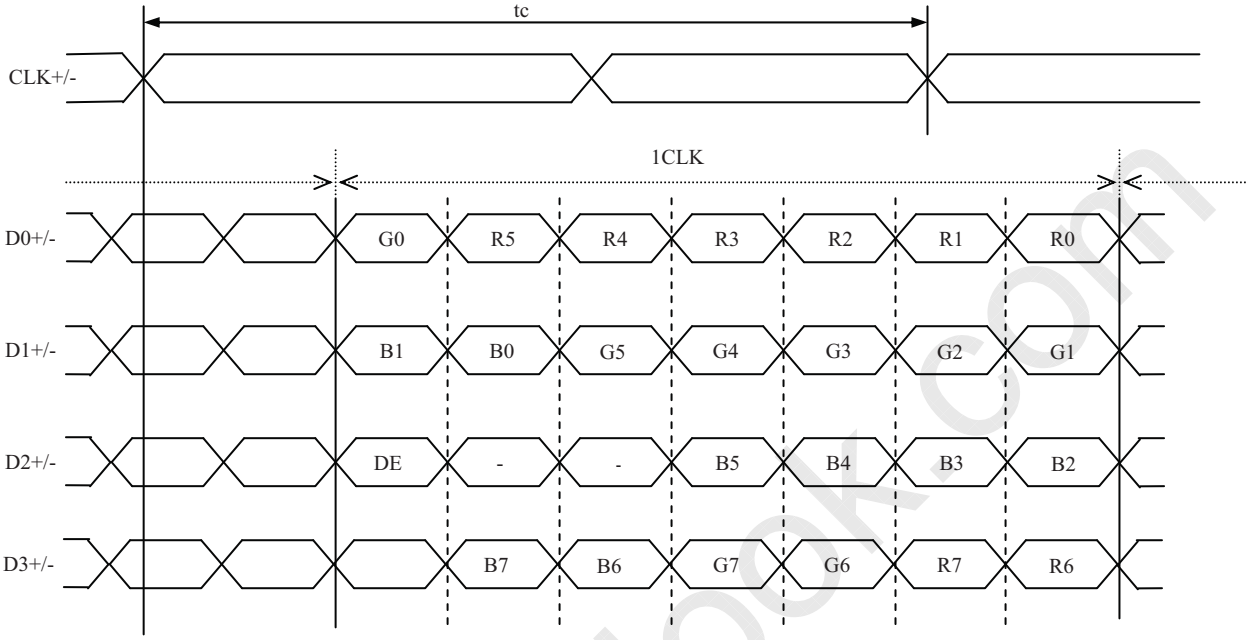
(2) Input data signal: 6bit



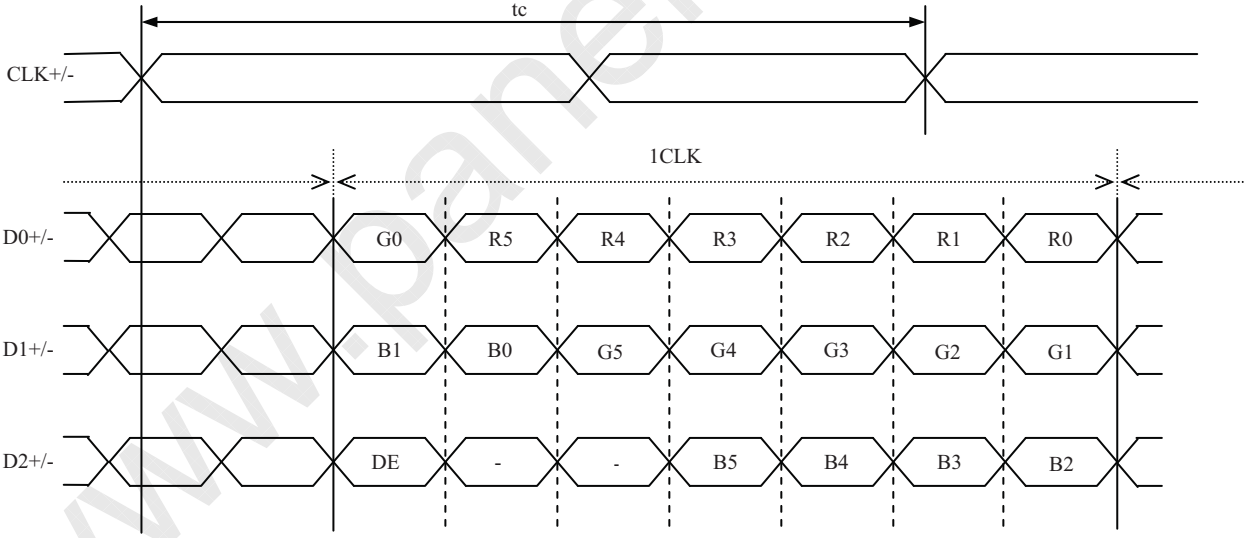
Note1: Recommended transmitter: DS90C383 (National Semiconductor) or equivalent
Note2: LSB (Least Significant Bit) – R0, G0, B0 MSB (Most Significant Bit) – R5, G5, B5
Note3: Twist pair wires with 100Ω (Characteristic impedance) should be used between LCD panel signal processing board and LVDS transmitter.
Note4: Input signals to TXIN24, TXIN25, TXIN27, TXIN5, TXIN10, TXIN11, TXIN16, TXIN17 and TXIN23 are not used inside the product, but do not keep TXIN24, TXIN25, TXIN27, TXIN5, TXIN10, TXIN11, TXIN16, TXIN17 and TXIN23 open to avoid noise problem.

4.5.5 Input data mapping

(1) Input data signal: 8bit



(2) Input data signal: 6bit



4.6 DISPLAY COLORS AND INPUT DATA SIGNALS

4.6.1 16,194,277 colors

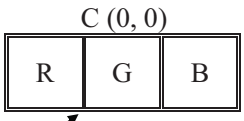
Display colors		Data signal (0: Low level, 1: High level)																							
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Red gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	dark	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑					:								:								:			
	↓					:								:								:			
	bright	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	↑					:								:								:			
	↓					:								:								:			
	bright	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Blue gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	↑					:								:								:			
	↓					:								:								:			
	bright	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

4.6.2 262,144 colors

Display colors		Data signal (0: Low level, 1: High level)																	
		R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0
Basic colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Magenta	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	Cyan	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Red gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	dark	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑				:						:						:		
	↓				:						:						:		
	bright	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
		1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Green gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	dark	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	↑				:						:						:		
	↓				:						:						:		
	bright	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0
		0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
Blue gray scale	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	↑				:						:						:		
	↓				:						:						:		
	bright	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1
		0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

4.7 DISPLAY POSITIONS

The following table is the coordinates per pixel.



C(0, 0)	C(1, 0)	• • •	C(X, 0)	• • •	C(798, 0)	C(799, 0)
C(0, 1)	C(1, 1)	• • •	C(X, 1)	• • •	C(798, 1)	C(799, 1)
• • •	• • •	• • •	• • •	• • •	• • •	• • •
C(0, Y)	C(1, Y)	• • •	C(X, Y)	• • •	C(798, Y)	C(799, Y)
• • •	• • •	• • •	• • •	• • •	• • •	• • •
C(0, 766)	C(1, 598)	• • •	C(X, 598)	• • •	C(798, 598)	C(799, 598)
C(0, 767)	C(1, 599)	• • •	C(X, 599)	• • •	C(798, 599)	C(799, 599)

4.8 DISPLAY DIRECTIONS

The following figures are seen from a front view.

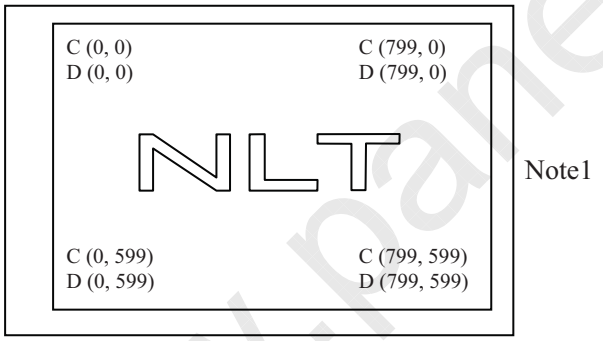


Figure1. Normal scan (DPS: Low or Open)

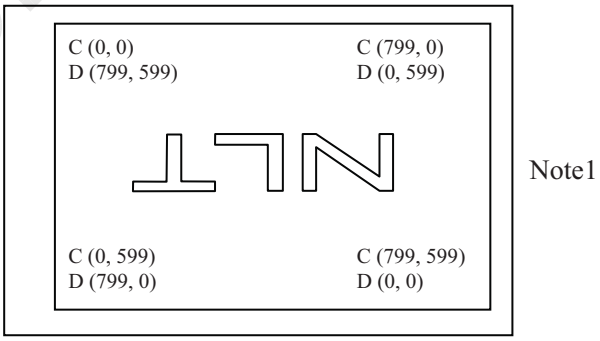


Figure2. Reverse scan (DPS: High)

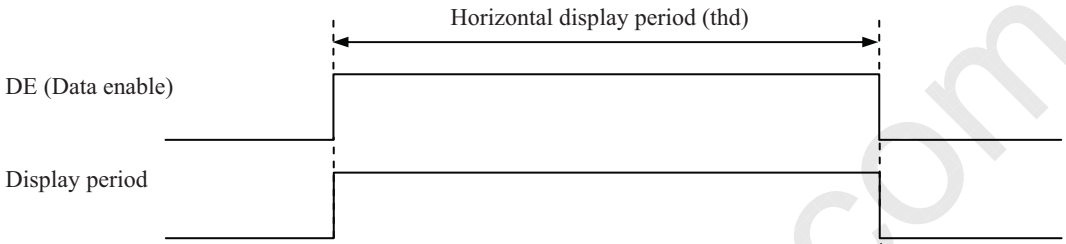
Note1: Meaning of C (X, Y) and D (X, Y)
C (X, Y): The coordinates of the display position (See "**4.7 DISPLAY POSITIONS**".)
D (X, Y): The data number of input signal for LCD panel signal processing board

4.9 INPUT SIGNAL TIMINGS

4.9.1 Outline of input signal timings

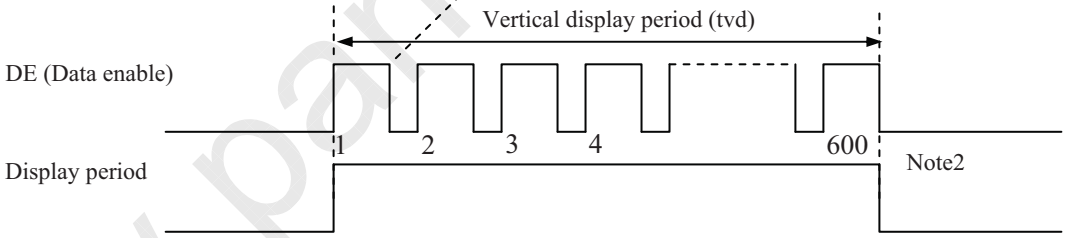
• Horizontal signal

Note1



• Vertical signal

Note1



Note1: This diagram indicates virtual signal for set up to timing.
Note2: See "**4.9.3 Input signal timing chart**" for the pulse number.

4.9.2 Timing characteristics

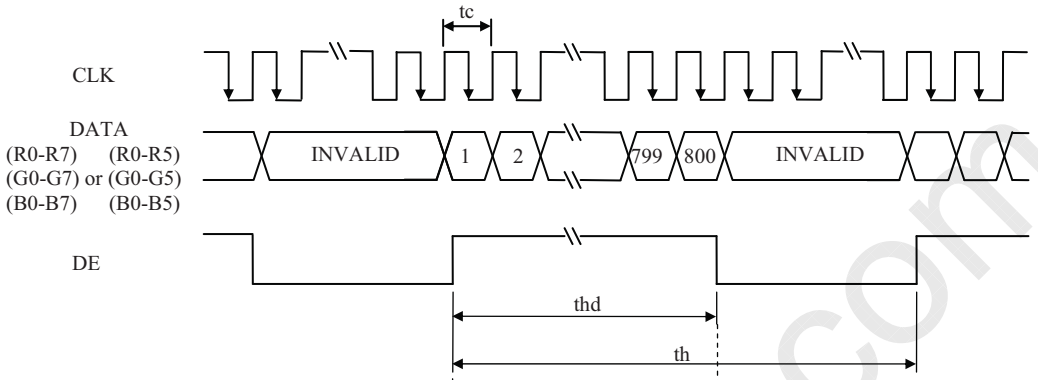
(Note1, Note2, Note3)

Parameter			Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency		1/tc	34.0	39.8	48.3	MHz	25.13 ns (typ.)
	Duty		-	-			-	-
	Rise time, Fall time		-				ns	
DATA	CLK-DATA	Setup time	-	-			ns	-
		Hold time	-				ns	
	Rise time, Fall time		-				ns	
DE	Horizontal	Cycle	th	21.23	26.5	31.85	µs	37.69 kHz (typ.)
				920	1,056	1,240	CLK	
		Display period	thd	800			CLK	-
	Vertical (One frame)	Cycle	tv	13.33	16.67	20	ms	60.0 Hz (typ.)
				608	628	650	H	
		Display period	tvd	600			H	
	CLK-DE	Setup time	-	-			ns	-
		Hold time	-				ns	
	Rise time, Fall time		-				ns	

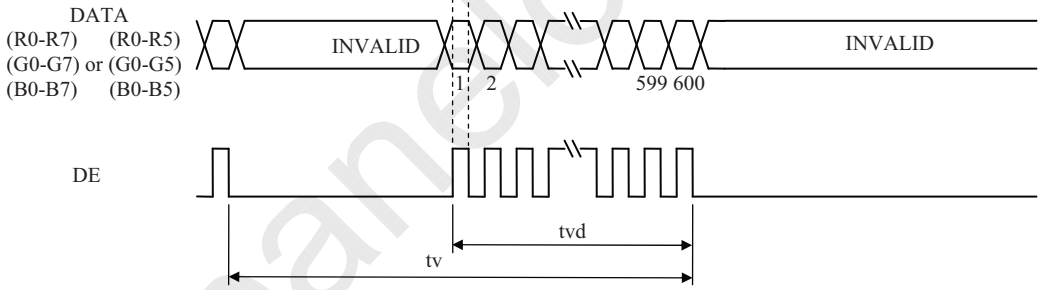
Note1: Definition of parameters is as follows.
tc= 1CLK, th= 1H
Note2: See the data sheet of LVDS transmitter.
Note3: Vertical cycle (tv) should be specified in integral multiple of Horizontal cycle (th).

4.9.3 Input signal timing chart

Horizontal timing



Vertical timing



4.10 OPTICS

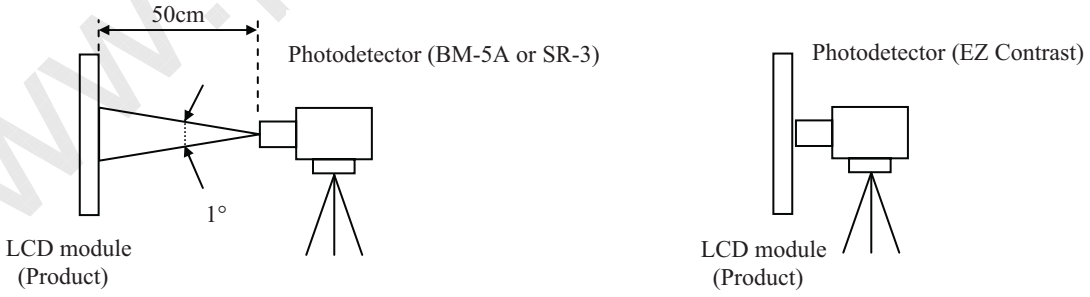
4.10.1 Optical characteristics

(Note1, Note2)

Parameter		Condition	Symbol	min.	typ.	max.	Unit	Measuring instrument	Remarks
Luminance		White at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	L	280	450	-	cd/m^2	BM-5A	-
Contrast ratio		White/Black at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	CR	300	700	-	-	BM-5A	Note3
Luminance uniformity		White θR= 0°, θL= 0°, θU= 0°, θD= 0°	LU	-	1.25	(1.33)	-	BM-5A	Note4
Chromaticity	White	**x** coordinate	Wx	(0.263)	0.313	(0.363)	-	SR-3	Note5
		y coordinate	Wy	(0.279)	0.329	(0.379)	-		
	Red	**x** coordinate	Rx	-	(0.589)	-	-		
		y coordinate	Ry	-	(0.339)	-	-		
	Green	**x** coordinate	Gx	-	(0.328)	-	-		
		y coordinate	Gy	-	(0.592)	-	-		
	Blue	**x** coordinate	Bx	-	(0.151)	-	-		
		y coordinate	By	-	(0.095)	-	-		
Color gamut		θR= 0°, θL= 0°, θU= 0°, θD= 0° at center, against NTSC color space	C	-	55	-	%		
Response time		White to Black	Ton	-	10	(20)	ms	BM-5A	Note6 Note7
		Black to White	Toff	-	25	(30)	ms		
Viewing angle	Right	θU= 0°, θD= 0°, CR≥ 10	θR	-	80	-	°	BM-5A or EZ Contrast	Note8
	Left	θU= 0°, θD= 0°, CR≥ 10	θL	-	80	-	°		
	Up	θR= 0°, θL= 0°, CR≥ 10	θU	-	65	-	°		
	Down	θR= 0°, θL= 0°, CR≥ 10	θD	-	75	-	°		

Note1: These are initial characteristics.
Note2: Measurement conditions are as follows.
Ta= 25°C, VCC= 3.3V, VDD= 12.0V, PWM: Duty 100%,
Display mode: SVGA, Horizontal cycle= 1/37.69kHz, Vertical cycle= 1/60.0Hz,
DPS= Low or Open: Normal display

Optical characteristics are measured at luminance saturation 20minutes after the product works, in the dark room. Also measurement methods are as follows.



Note3: See "**4.10.2 Definition of contrast ratio**".
Note4: See "**4.10.3 Definition of luminance uniformity**".
Note5: These coordinates are found on CIE 1931 chromaticity diagram.
Note6: Product surface temperature: TopF= (30)°C
Note7: See "**4.10.4 Definition of response times**".
Note8: See "**4.10.5 Definition of viewing angles**".

4.10.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

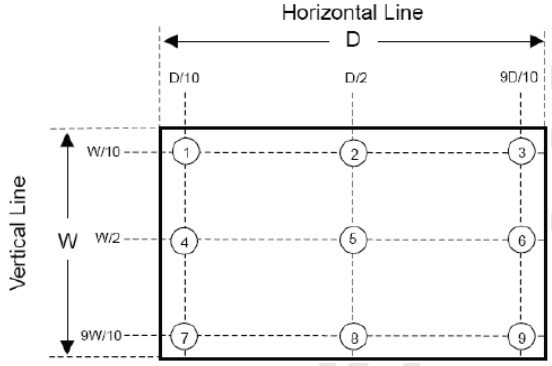
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

4.10.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

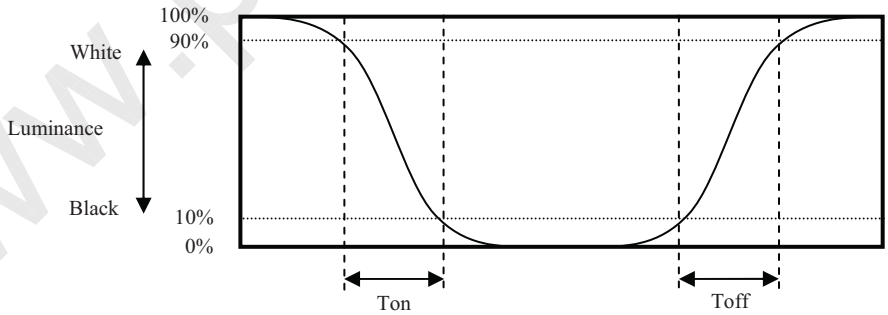
$$\text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑨}}{\text{Minimum luminance from ① to ⑨}}$$

The luminance is measured at near the 9 points shown below.

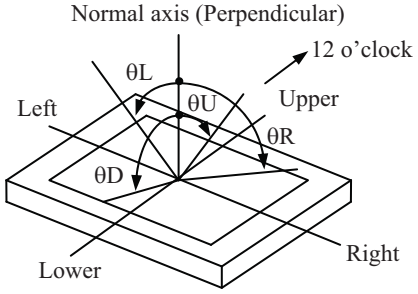


4.10.4 Definition of response times

Response time is measured at the time when the luminance changes from "black" to "white", or "white" to "black" on the same screen point, by photo-detector. Ton is the time when the luminance changes from 10% up to 90%. Also Toff is the time when the luminance changes from 90% down to 10% (See the following diagram.).



4.10.5 Definition of viewing angles



5. ESTIMATED LUMINANCE LIFETIME

The luminance lifetime is the time from initial luminance to half-luminance.

This lifetime is the estimated value, and is not guarantee value.

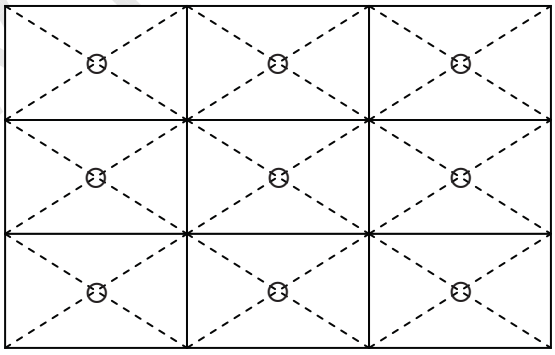
Condition		Estimated luminance lifetime (Life time expectancy) Note1, Note2, Note3	Unit
LED elementary substance	25°C (Ambient temperature of the product) Continuous operation, PWM Duty: 100%	50,000	h

Note1: Life time expectancy is mean time to half-luminance.
Note2: Estimated luminance lifetime is not the value for an LCD module but the value for LED elementary substance.
Note3: By ambient temperature, the lifetime changes particularly. Especially, in case the product works under high temperature environment, the lifetime becomes short.

6. RELIABILITY TESTS

Test item	Condition	Judgment Note1
High temperature and humidity (Operation)	① 50 ± 2°C, RH= 80%, 240hours ② Display data is black.	No display malfunctions
High temperature (Operation)	① 70 ± 3°C, 240hours ② Display data is black.	
Thermal shock (Non operation)	① -20 ± 3°C…30minutes 60 ± 3°C…30minutes ② 100cycles, 1hour/cycle ③ Temperature transition time is within 5 minutes.	
ESD (Operation)	Contact Discharge ① 150pF, 150Ω, ±8kV ② 9 places on a panel surface Note2 ③ 25 times each places at 1 sec interval Air Discharge ① 150pF, 330Ω, ±15kV ② 9 places on a panel surface Note2 ③ 25 times each places at 1 sec interval	
Vibration (Non operation)	① 5 to 100Hz, 11.76m/s^2 ② 1 minute/cycle ③ X, Y, Z directions ④ 50 times each directions	
Mechanical shock (Non operation)	① 490m/s^2, 11ms ② X, Y, Z directions ③ 3 times each directions	

Note1: Display and appearance are checked under environmental conditions equivalent to the inspection conditions of defect criteria.
Note2: See the following figure for discharge points.



7. PRECAUTIONS

7.1 MEANING OF CAUTION SIGNS

The following caution signs have very important meaning. **Be sure to read "7.2 CAUTIONS" and "7.3 ATTENTIONS"!**

This sign has the meaning that a customer will be injured or the product will sustain damage if the customer practices wrong operations.

This sign has the meaning that a customer will be injured if the customer practices wrong operations.

7.2 CAUTIONS

* **Do not shock and press the LCD panel and the backlight! There is a danger of breaking, because they are made of glass.**

7.3 ATTENTIONS

7.3.1 Handling of the product

① Take hold of both ends without touching the circuit board when the product (LCD module) is picked up from inner packing box to avoid broken down or misadjustment, because of stress to mounting parts on the circuit board.
② When the product is put on the table temporarily, display surface must be placed downward.
③ When handling the product, take the measures of electrostatic discharge with such as earth band, ionic shower and so on, because the product may be damaged by electrostatic.
④ The product must be installed using mounting holes without undue stress such as bends or twist (See outline drawings). And do not add undue stress to any portion (such as bezel flat area). Bends or twist described above and undue stress to any portion may cause display mura.
⑤ Do not press or rub on the sensitive product surface. When cleaning the panel surface, wipe it with a soft dry cloth.
⑥ Do not push or pull the interface connectors while the product is working. When handling the product, use of an original protection sheet on the product surface (polarizer) is recommended for protection of product surface. Adhesive type protection sheet may change color or characteristics of the polarizer.
⑦ Usually liquid crystals don't leak through the breakage of glasses because of the surface tension of thin layer and the construction of LCD panel. But, if you contact with liquid crystal by any chance, please wash it away with soap and water.

7.3.2 Environment

① Do not operate or store in high temperature, high humidity, dewdrop atmosphere or corrosive gases. Keep the product in packing box with antistatic pouch in room temperature to avoid dusts and sunlight, when storing the product.
② In order to prevent dew condensation occurred by temperature difference, the product packing box must be opened after enough time being left under the environment of an unpacking room. Evaluate the storage time sufficiently because dew condensation is affected by the environmental temperature and humidity. (Recommended leaving time: 6 hours or more with the original packing state after a customer receives the package)
③ Do not operate in high magnetic field. If not, circuit boards may be broken.
④ This product is not designed as radiation hardened.

7.3.3 Characteristics

The following items are neither defects nor failures.

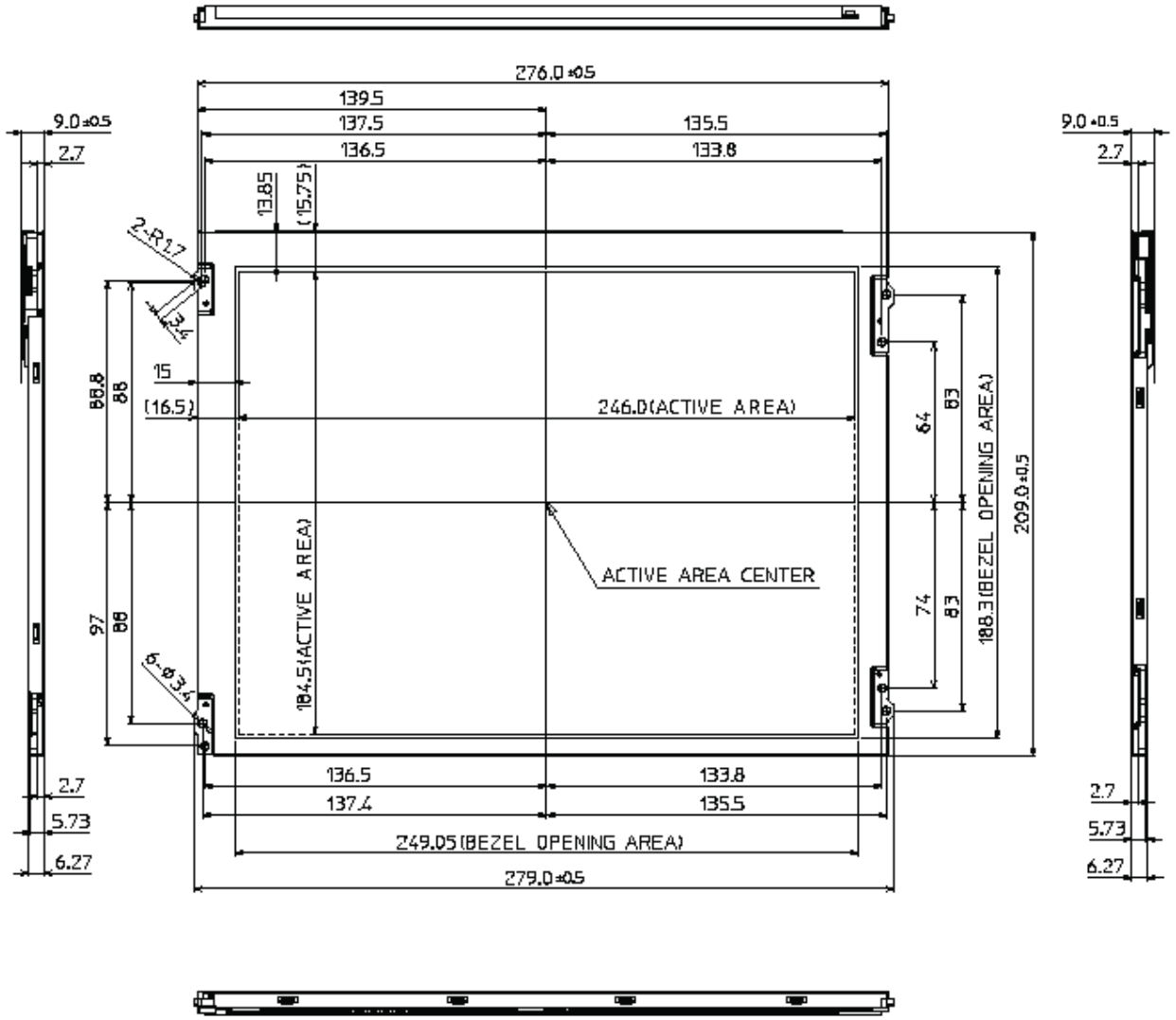
① Characteristics of the LCD (such as response time, luminance, color uniformity and so on) may be changed depending on ambient temperature. If the product is stored under condition of low temperature for a long time, it may cause display mura. In this case, the product should be operated after enough time being left under condition of operating temperature.
② Display mura, flickering, vertical streams or tiny spots may be observed depending on display patterns.
③ Do not display the fixed pattern for a long time because it may cause image sticking. Use a screen saver, if the fixed pattern is displayed on the screen.
④ The display color may be changed depending on viewing angle because of the use of condenser sheet in the backlight.
⑤ Optical characteristics may be changed depending on input signal timings.

7.3.4 Others

① All GND, VCC and VDD terminals should be used without any non-connected lines.
② Do not disassemble a product or adjust variable resistors.
③ See "REPLACEMENT MANUAL FOR LAMP HOLDER SET", when replacing lamp holder set.
④ Pack the product with the original shipping package, in order to avoid any damages during transportation, when returning the product to NLT for repairing and so on.

8. OUTLINE DRAWINGS

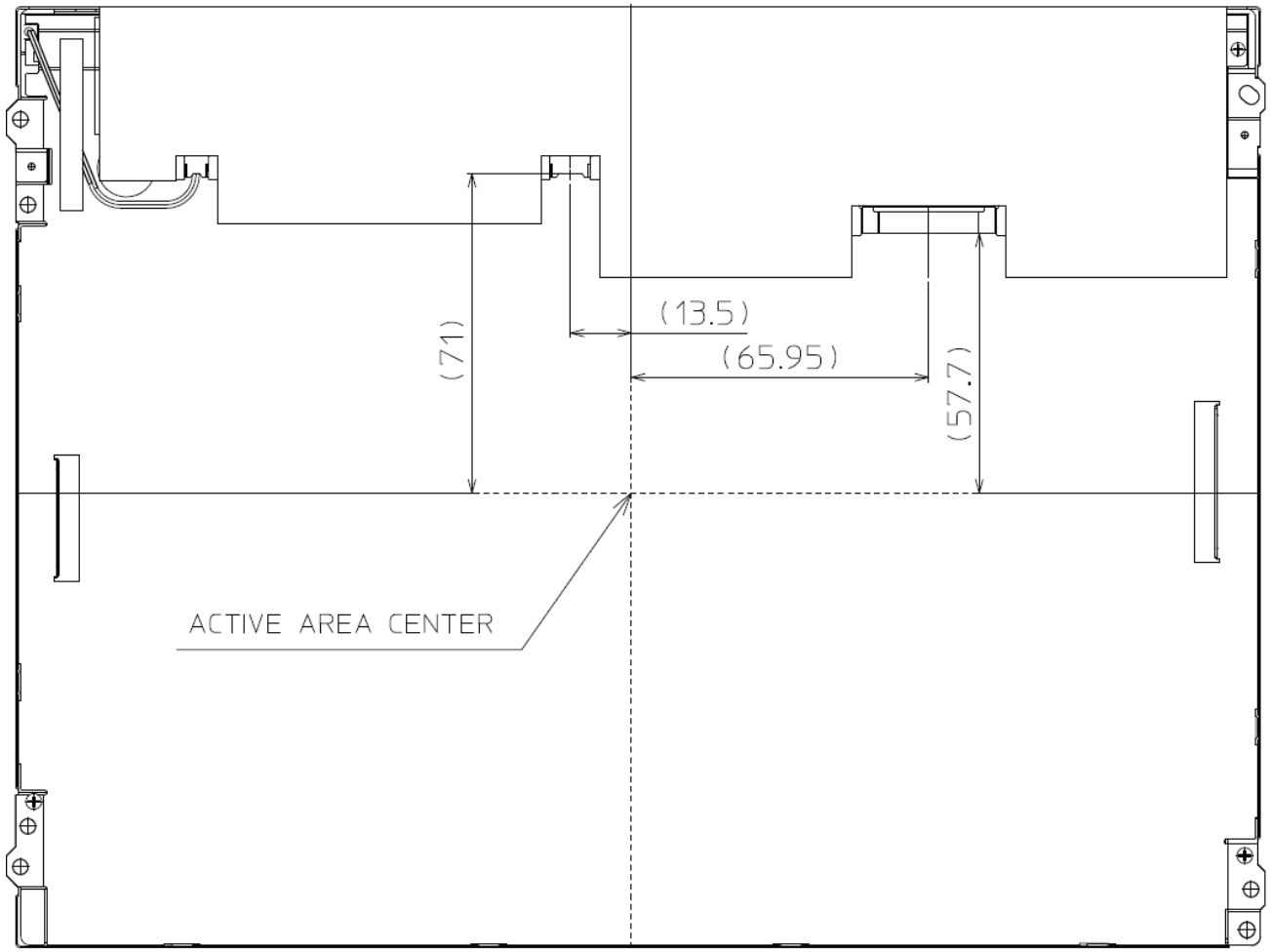
8.1 FRONT VIEW



Note1: The values in parentheses are for reference.
Note2: The torque for product mounting screws must never exceed 0.294N·m.

Unit: mm

8.2 REAR VIEW



Note1: The values in parentheses are for reference.
Note2: The torque for product mounting screws must never exceed 0.294N·m.

Unit: mm

REVISION HISTORY

The inside of latest specifications is revised to the clerical error and the major improvement of previous edition. Only a changed part such as functions, characteristic value and so on that may affect a design of customers, are described especially below.

Edition	Document number	Prepared date	Revision contents and signature
1st edition	DOD-MD -1226	Nov. 16, 2011	**Revision contents** New issue **Writer** *Approved by* T. KANATSU *Checked by* ——— *Prepared by* K. YUGE
2nd edition	DOD-MD -1243	Jan. 12, 2012	**Revision contents** P7 ABSOLUTE MAXIMUM RATINGS • Storage temperature: -10 to +70°C → -30 to +80°C • Operating temperature- Front / Rear : 0 to +60°C → -20 to +70°C P11 4.5.1 LCD panel signal processing board • CN2 socket (LCD module side):TBD → MSB24038P5 **Writer** *Approved by* T. KANATSU *Checked by* ——— *Prepared by* T. KANATSU
3rd edition	DOD-MD -1261	Feb. 9, 2012	**Revision contents** P20 4.9.2 Timing characteristics • CLK Frequency: TBD(min.), TBD(max.) → 34.0(min.), 48.3(max.) **Writer** *Approved by* T. KANATSU *Checked by* ——— *Prepared by* K. YUGE
4th edition	DOD-PP-1392	Mar. 16, 2012	**Revision contents** P4 Outline • Structure and principle • NL8060AC31-XX → NLB121SV01L-01 • … processing circuit, …→ … processing board, … • Features • … lamp holder for backlight → … lamp for backlight P5 General specifications • Display color • (…, 6-8Bit SEL terminal= VCC) → (…, FRC terminal= VCC) • (…, 6-8Bit SEL terminal= GND or Open) → (…, FRC terminal= GND or Open) • Weight: TBD → 540 g (typ.) • Viewing angle • Vertical: Up side 80° (typ.) → 65° (typ.) • Down side 60° (typ.) → 75° (typ.) • Polarizer pencil-hardness (addition) • Luminance: 400cd/m^2 (typ.) → 450cd/m^2 (typ.) P7 Detailed specifications • Mechanical specifications • Weight: TBD (typ.) g → 540 (typ.) g • Absolute maximum ratings • Power supply voltage- LED driver: TBD V → -0.3 to +26.5 V • Input voltage for signals- Function signal for LED driver • PWM: TBD V → -0.3 to +26.5 V • BRTC: TBD V → -0.3 to +26.5 V

PRELIMINARY

REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and signature
4th edition	DOD-PP-1392	Mar. 16, 2012	**Revision contents** P8 Electrical characteristics • LCD panel signal processing board • Power supply current: TBD (typ.) mA → 280 (typ.) mA • Input voltage for DSP and FRC signals • High: TBD (min.), TBD (max.) V → 0.7*VCC (min.), VCC (max.) V • Low: TBD (max.) → 0.3*VCC (max.) V • Note2: Gray pattern → Pattern for maximum current P9 Backlight lamp (Title is changed) • Power supply voltage: TBD (min., max.) V → 10.8 (min.), 12.6 (max.) V • Power supply current: TBD (typ.) mA → 480 (typ.) mA • Permissible ripple voltage: TBD (max.) mVp-p → 200 (max.) mVp-p • Input voltage for PWM signals • High: TBD (min., max.) V → 1.2 (min.), - (max.)V • Low: TBD (min., max.) V → - (min.), 0.4 (max.) V • Input voltage for BRTC signals • High: TBD (min., max.) V → 1.5 (min.), - (max.) V • Low: TBD (max.) V → 0.8 (max.) V • PWM frequency: 100(min), 200(typ.), 10K(max.)Hz → 200(min), -(typ.), 10k(max.)Hz • PWM pulse width: TBD (min) μs → 1 (min) μs P10 LED driver board (addition) P11 Connections and functions for interface pins • LCD panel signal processing board • Pin No.4- Remarks: Note3, Note4 (addition) • Pin No.19- Remarks: Note5 (addition) • Backlight lamp (Title is addition) P13-15 Connection between receiver and transmitter for LVDS • (1) Input data signal • Figure (revised) • Note4: TXIN23 (addition) • (2) nput data signal: 6bit • Figure (revised) • Note4: TXIN27, TXIN5, TXIN10, TXIN11, TXIN16, TXIN17 and TXIN23 (addition) P16 Display colors and input data signals (Title is addition) P22 Timing characteristics • DE- Horizontal- Cycle: TBD (min., max.) μs → 21.23 (min.), 31.85 (max.) μs : TBD (min., max.) CLK → 920 (min.), 1,240 (max.) CLK • DE- Vertical- Cycle: TBD (min., max.) ms → 13.33 (min.), 20 (max.) ms : TBD (min., max.) H → 608 (min.), 650 (max.) H P22 Optics • Optical characteristics • Luminance: 400 (typ.) cd/m^2 → 450 (typ.) cd/m^2 • Viewing angle- Up: 80 (typ.) ◦ → 65 (typ.) ◦ - Down: 60 (typ.) ◦ → 75 (typ.) ◦ - Remarks: EZ Contrast (addition) • Note2: Photodetector (EZ Contrast) (addition) P25 Reliability tests (addition) **Writer** *Approved by* T. OGAWA *Checked by* _____ *Prepared by* A. KUMANO
5th edition	DOD-PP-1393	Mar. 29, 2012	**Revision contents** P3 CONTENTS • 4.6.1 16,777,216 colors → • 4.6.1 16,194,277 colors P5 GENERAL SPECIFICATIONS • Display color: 16,777,216 colors → 16,194,277 colors • Module size: 279.5mm(H)(typ.) … → 279.0mm(H)(typ.) …

REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and signature
5th edition	DOD-PP-1393	Mar. 29, 2012	**Revision contents** P7 4.1 MECHANICAL SPECIFICATIONS • Module size: 279.5±0.5(W) … → 279.0±0.5(W) … P11 Connections and functions for interface pins • LCD panel signal processing board • CN1: FI-SE20P-HFE (JAE) or Equivalent → P240420 (Produced by STM) • Backlight lamp • CN2: MSB24038P5 → P24038P5 (Produced by STM) P16 DISPLAY COLORS AND INPUT DATA SIGNALS • 4.6.1 16,777,216 colors → • 4.6.1 16,194,277 colors **Writer** *Approved by* T. OGAWA *Checked by* _____ *Prepared by* A. KUMANO
6th edition	DOD-PP-1414	Apr. 26, 2012	**Revision contents** P7 Detailed specifications • Absolute maximum ratings • Power supply voltage- LCD panel: -0.3 to +4.0 → -0.3 to +3.6 P9 Electrical characteristics • Fuse • VCC- Type: TBD → FCC16152AB - Supplier: TBD → KAMAYA ELECTRIC Co., Ltd. - Rating: TBD A, TBD V → 1.5A, 36V - Fusing current: TBD A → 3.0A • VDD- Type: TBD → FCC16152AB - Supplier: TBD → KAMAYA ELECTRIC Co., Ltd. - Rating: TBD A, TBD V → 1.5A, 36V - Fusing current: TBD A → 3.0A P10 Power supply voltage sequence • LED driver board: VDD (Figure is addition) P11 Connections and functions for interface pins • LCD panel signal processing board • CN1- Adaptable plug: P240420 (Produced by STM) → DF14-20S-1.25C (Hirose Electric Co., Ltd. (HRS)) **Writer** *Approved by* T. OGAWA *Checked by* _____ *Prepared by* A. KUMANO
7th edition	DOD-PP-1444	June 8, 2012	**Revision contents** P8 Electrical Characteristics • LCD panel signal processing board • Permissible ripple voltage(VRPC): 100 (max.) mVp-p → 300 (max.) mVp-p P9 Power supply voltage ripple • VCC- Ripple voltage: ≤ 100 mVp-p → ≤ 300 mVp-p • VDD- Ripple voltage: TBD mVp-p → ≤ 200 mVp-p P11 Backlight lamp • CN2- Pin No.1- Signal: Power supply (12V) → Power supply - Pin No.3- Remarks: 5V-On, 0V-Off → High- On / Low- Off P28-29 Outline drawings • Front view (revised) • 2- R1.7, 3.4, 6- ϕ3.4 (addition) • 249.05±0.3 → 249.05, 188.3±0.3 → 188.3, 137.5 → 137.4, 15.75 → (15.75), 16.5 → (16.5), 9 (typ.) → 9.0±0.5 (2points) • Upper and Lower side (addition)

REVISION HISTORY

Edition	Document number	Prepared date	Revision contents and signature
7th edition	DOD-PP-1444	June 8, 2012	**Revision contents** • Rear view (revised) • ACTIVE AREA CENTER, (71) (addition) • 13.5 → (13.5), 65.95 → (65.95), 56.7 → (57.7) **Writer** *Approved by* T. OGAWA *Checked by* ——— *Prepared by* A. KUMANO
8th edition	DOD-PP-1446	June 13, 2012	**Revision contents** P7 Absolute Maximum Ratings • Input voltage for signals- Display signals(VD): -0.3 to +3.3 V → -0.3 to +1.98 V - Function signals(VF): -0.3 to +3.3 V → -0.3 to VCC P22 Optical characteristics • Chromaticity- White- Wx: TBD (min., max.) → (0.263) (min.), (0.363) (max.) - Wy: TBD (min., max.) → (0.279) (min.), (0.379) (max.) - Rx, Ry: TBD (typ.) → (0.589), (0.339) (typ.) - Gx, Gy: TBD (typ.) → (0.328), (0.592) (typ.) - Bx, By: TBD (typ.) → (0.151), (0.095) (typ.) • Note6: TopF= TBD °C → TopF= (30) °C **Signature of writer** *Approved by* T. OGAWA *Checked by* ——— *Prepared by* A. KUMANO